Exploiting demand structure for efficiently serving arcs and edges in networks

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We study the problem of finding minimum-length routes for a fleet of vehicles of equal capacity that are initially located in a vehicle depot and have to serve the demands of all clients located in a transportation network. It is canonical to model the transportation network as a graph whose edges are weighted by distances. Yet there is some freedom in modeling the clients: in the Capacitated Vehicle Routing Problem (CVRP), the clients are a subset of the vertices of the graph, whereas in the Capacitated Arc Routing Problem (CARP), the clients are a subset of the arcs or edges of the graph. CARP models tasks where the roads of the network themselves are the clients or all clients along a road have to be served (e.g., in street sweeping, household waste collection, or meter reading).

Both CVRP and CARP are NP-hard and can easily be translated into each other. Due to this perceived equivalence, research is mostly concentrated around the older CVRP. Nevertheless, solving route planning tasks using CARP rather than CVRP, when applicable, is rewarding: based on a recent survey and recent work [1, 2] on the parameterized and approximation complexity of arc routing problems, this talk shows what makes CARP significantly easier than CVRP and presents recent theoretical and experimental results on fixed-parameter algorithms for efficiently solving NP-hard variants of CARP by exploiting the structure of the subgraph that is induced by the client arcs or edges.

References

[1] René van Bevern, Rolf Niedermeier, Manuel Sorge, and Mathias Weller. Complexity of arc routing problems. In *Arc Routing: Problems, Methods, and Applications*, MOS-SIAM Series on Optimization. SIAM, 2014.

[2] René van Bevern, Christian Komusiewicz, and Manuel Sorge. Approximation algorithms for mixed, windy, and capacitated arc routing problems. In *Proceedings of the 15th Workshop on Algorithmic Approaches for Transportation Modeling, Optimization, and Systems (ATMOS'15)*, volume 48 of *OpenAccess Series in Informatics (OASIcs)*. Schloss Dagstuhl–Leibniz-Zentrum für Informatik, 2015.